

Virtual Reality as a Tool in Early Interventions

Brenda K. Wiederhold, Ph.D., MBA, BCIA, and Mark D. Wiederhold, MD, Ph.D., FACP

The Virtual Reality Medical Center
6160 Cornerstone Court East, Suite 155
San Diego, CA 92121
USA

bwiederhold@vrphobia.com

ABSTRACT

Post-traumatic stress disorder (PTSD) is one of the most debilitating psychological disorders affecting United States soldiers and veterans who have been exposed to combat. Treatments for PTSD include psychological debriefing, which has been criticized lately for its questionable efficacy, and imaginal exposure therapy, which is problematic in that some PTSD sufferers are unable to engage well enough to elicit the necessary response. The weaknesses inherent in these treatments have created a pressing need for alternatives. One promising option is to utilize virtual reality graded exposure therapy (VRGET). The Virtual Reality Medical Center (VRMC) is currently conducting research, funded by the Office of Naval Research (ONR) and the Telemedicine and Advanced Technology Research Center (TATRC), studying virtual reality therapy as an early intervention tool for PTSD.

1.0 INTRODUCTION

Virtual reality (VR) is a relatively new technology with healthcare applications being developed for surgical procedures, medical therapy, preventative medicine, rehabilitation, and medical education and training. VR has also been shown to be highly effective as a psychotherapeutic tool. It is often used to distract patients during painful medical procedures, or to provide graded exposure during treatment for anxiety disorders, such as phobias, or post-traumatic stress disorder (PTSD).

Combat-related PTSD is the topic of the current paper. After summarizing the prevalence and symptoms of PTSD, we discuss treatment options, focusing on VR therapy. We then describe the research that we are conducting at the Virtual Reality Medical Center (VRMC), in conjunction with the Office of Naval Research (ONR) and the U.S. Army's Telemedicine and Advanced Technology Research Center (TATRC), studying VR therapy as an early intervention tool for war-related PTSD.

2.0 POST-TRAUMATIC STRESS DISORDER

PTSD affects an estimated 5.2 million Americans in any given year [1], often resulting in a diminished quality of life and considerable emotional suffering. The current rate of PTSD among Army and Marine Corps combatants returning from duty in Iraq is about 19%. Military experts believe the rate is following historical patterns for sustained ground combat and is still increasing. A continuing upward trend seems especially likely given the unique nature of the Iraq theater. According to recent reports, the number of Iraq War

Wiederhold, B.K.; Wiederhold, M.D. (2006) Virtual Reality as a Tool in Early Interventions. In *Human Dimensions in Military Operations – Military Leaders' Strategies for Addressing Stress and Psychological Support* (pp. 45-1 – 45-8). Meeting Proceedings RTO-MP-HFM-134, Paper 45. Neuilly-sur-Seine, France: RTO. Available from: <http://www.rto.nato.int/abstracts.asp>.

Report Documentation Page				Form Approved OMB No. 0704-0188	
Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.					
1. REPORT DATE 01 APR 2006		2. REPORT TYPE N/A		3. DATES COVERED -	
4. TITLE AND SUBTITLE Virtual Reality as a Tool in Early Interventions				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) The Virtual Reality Medical Center 6160 Cornerstone Court East, Suite 155 San Diego, CA 92121 USA				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release, distribution unlimited					
13. SUPPLEMENTARY NOTES See also ADM001955.					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT UU	18. NUMBER OF PAGES 8	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			

soldiers who will experience PTSD is higher than the Gulf War due to such factors as ground combat and long deployments [2]. A recent survey of Soldiers and Marines deployed in Iraq describes a very high level of combat experiences, with more than 90% of respondents reporting being shot at [3].

Symptoms of PTSD typically appear within three months of the trauma, and can occur at any age. Symptoms, including re-experiencing the trauma, avoidance, and hyperarousal, can vary over time. Research studies have found a consistently high prevalence of drug and/or alcohol abuse in those seeking PTSD treatment. In a large scale study, 34.5% of individuals with PTSD reported drug abuse, with another 40% reporting alcohol abuse [4]. Additionally, in a controlled study from 1991, 91% of Vietnam combat veterans diagnosed with PTSD met lifetime criteria for substance abuse [5].

3.0 CURRENT TREATMENTS FOR PTSD

PTSD is a disabling, often chronic problem, which frequently results in poor treatment outcomes and disability payments to PTSD-diagnosed veterans that may continue for years, if not decades. Front-line antidepressant medications for the disorder rarely yield better than a 40% reduction in Clinician Administered PTSD Scale (CAPS) scores, and most patients still meet criteria for PTSD at the end of an adequate treatment trial [6]. Regarding psychotherapy, only 44% of all those who enter treatment are classified at the end of the treatment period as improved [7].

3.1 Psychological Debriefing

Psychological debriefing (PD), the best-known and most widely-used intervention designed to mitigate acute distress and prevent long-term psychopathology like PTSD, is currently undergoing intense controversy. Some critics question its efficacy [8, 9] while others claim it may actually *increase* the risk of people developing long-term psychological symptoms following a traumatic event [10].

3.2 Imaginal Exposure Therapy

The current standard of care for PTSD is imaginal exposure (IE) therapy, the efficacy of which has been established in multiple studies with diverse trauma populations [11, 12, 13]. However, since avoidance of trauma reminders is inherent in PTSD, some patients are unable to engage either emotionally or cognitively in IE. In studies that address treatment non-responders, failure to engage emotionally or visualize well enough to elicit an emotional response is cited as most predictive of non-response since the fear structure is not accessed and therefore not open to change [12, 14, 15]. Exposure therapy for PTSD has not been done in real life (in vivo) as often as for other anxiety disorders due to the impractical, and often dangerous, nature of recreating many traumas [5].

3.3 Virtual Reality Therapy

The questionable value of PD and IE recently has created a pressing need for alternatives. One promising option is to utilize virtual reality graded exposure therapy (VRGET). Often in PTSD treatment, it is neither practical nor advisable to re-expose the patient to the trauma in a real-world setting. VRGET, however, can effectively place the patient back into that scenario so that the necessary processing of memories can occur, allowing the individual to move through the trauma and on to recovery. By placing the patients in, for example, a virtual Iraqi setting, or other environment where a trauma has occurred, and then having them slowly experience that situation in a controlled way, the patient may begin to habituate to their specific PTSD symptoms and come to reappraise the situation, allowing emotional processing to fully occur.

Typically in VR therapy, small head-mounted display (HMD) goggles provide the patient a three-dimensional visual interface with a virtual environment. (See Figure 1.) A head-tracking system, computer joystick, or mouse allows the patient to navigate through a 360-degree view of the environment. Stereo earphones allow sound effects to be integrated into the environment.



Figure 1: VR Head-Mounted Device.

VRGET has been shown to be highly effective as a psychotherapeutic tool. It is often used to distract patients during painful medical procedures [16] or to provide graded exposure during treatment for anxiety disorders [17], such as phobias [18, 28].

3.3.1 Previous Research Regarding VR for PTSD Treatment

In recent years, VR has also been shown to be an effective treatment for PTSD in a variety of different populations [19, 21, 22, 23, 24, 25, 26, 27, 28].

3.3.1.1 VR for PTSD Treatment in Vietnam Veterans

Rothbaum and colleagues have used VR therapy to treat PTSD in Vietnam veterans. In an initial case study [19], a VRGET patient experienced a 34% decrease in PTSD symptoms and a 45% decrease in self-ratings of symptoms. In a second study of 10 veterans with PTSD [13], the 8 participants who were contacted at 6-month follow-up reported a decrease in symptoms ranging from 15% to 67%. In the third project [25], a case study, the patient reported a dramatic drop in symptom levels, verified by standard PTSD measures, in both 3- and 6-month follow-up assessments.

3.3.1.2 VR for PTSD Treatment in Survivors of Motor Vehicle Accidents (MVA)

VR therapy has also been utilized to treat PTSD in survivors of MVA. Walshe and colleagues tested the effectiveness of the combined use of computer-generated environments involving driving games and a VR driving environment in exposure therapy for the treatment of driving phobia following a motor vehicle accident [20]. Subjects were assessed at the beginning and end of therapy with measurements of physiology (e.g., heart rate, skin conductance, and respiration), subjective ratings of distress, rating scales for severity of fear of driving, post-traumatic stress disorder, depression, and achievement of target behaviors. The findings of this study suggest that VR may have a useful role in the treatment of PTSD even when co-morbid conditions such as post-traumatic stress disorder and depression are present.

3.3.1.3 VR for PTSD in World Trade Center Survivors and Earthquake Survivors

VR therapy also has been used successfully to treat survivors of the World Trade Center attacks of September 11, 2001. In a case study by Difede & Hoffman [23], after 6 VRGET therapy sessions, the woman showed a 90% reduction in symptoms of PTSD and an 83% reduction in symptoms of depression. After the patient completed therapy, an independent evaluator determined that she no longer met the criteria for PTSD, major depression, or any other psychiatric disorder. Preliminary results of a follow-up study in progress [31] showed a Clinician Administered PTSD Scale (CAPS) score decrease of 28% after 14 weeks in the VR group compared to 5% in the wait-list control (WLC) group. Of the 7 patients in the VR group, 5 were disaster-recovery workers and 6 had failed to respond to IE therapy.

In a 2003 study [24], earthquake survivors in Turkey were given one session of exposure to simulated earthquake tremors. Assessments were at pre- and post-session and at 2, 4, 8, and 12 weeks post-treatment. All measures showed significant improvement. At follow-up, 8 patients were markedly better and 2 were slightly improved.

3.3.2 VR as a Prevention Tool

Researchers are also utilizing VR as a prevention tool. One method being utilized in an attempt to prevent PTSD is Stress Inoculation Training (SIT). SIT is a technique to help “inoculate” individuals to future potentially traumatizing stressors. During preventative SIT, repeated exposure enables performers to gradually become desensitized to stimuli that may initially elicit such strong physiologic arousal that performance is impeded (i.e., “freezing in the line of fire”) and psychological trauma is likely.

There is some evidence that SIT can in fact reduce PTSD. For example, a group of 106 male British soldiers preparing for a 6-month tour of duty in Bosnia received a combination of pre-deployment stress training in combination with PD, and demonstrated a drastically reduced incidence of PTSD as compared to other military samples [29].

Additionally, the Virtual Reality Medical Center was recently funded for Phase II of a Defense Advanced Research Projects Agency (DARPA) grant to conduct SIT for combat medics to practice skills in a VR world, with stressors added, prior to deployment to Iraq. Phase I results [30] indicated that those trained in a VR simulation while having stressors added (being shot at while tending to the wounded) were able to perform skills more effectively in the test phase of the study as compared to those trained in a “sterile” VR environment (no one shooting at them while tending to the wounded). Those receiving SIT were able to develop divided attention skills, and learned to moderate physiological responses to stress while staying focused on the task at hand. Those not receiving SIT were pulled off task and experienced much more physiological arousal during the test phase (being shot at), which caused mistakes to be made (patients “died” or medics were “killed in action”).

3.3.3 VR as an Early Intervention Tool

While SIT is a promising option in terms of preventing PTSD, there is still a large population suffering from this disorder. The aforementioned case study by Difede and Hoffman [23] was the first to explore whether VRGET was effective in treating *acute* PTSD (within a few months after the traumatic event). The incredible improvement that the woman (who was a survivor of the 9/11 World Trade Center attack) showed as a result of VRGET points to the great potential of utilizing VR as an early intervention tool.

The Virtual Reality Medical Center, in conjunction with the Office of Naval Research (ONR) and the Telemedicine and Technology Research Center (TATRC), is working to provide a time-sensitive solution to military personnel who have been exposed to recent combat situations. We hope that by providing treatment for PTSD as early as possible, many of the co-morbid conditions which often occur, such as substance abuse, can be avoided. We also hope that, by intervening early, treatment response will be greater since the PTSD will not be as long-standing.

3.3.3.1 Treatment During Deployment (“In Theater”)

A project, funded by TATRC, allowed us to ship a VR system to Iraq in August of 2005. Although this project is still in its initial stages, our hope is that having a VR system in theater will allow for the earliest possible intervention and treatment of PTSD. Additionally, having the system in place in Iraq has enabled us to receive critical feedback from troops in theater regarding how the software could be modified in order to better meet their needs. Over the past decade, we have discovered that having the end user involved in the development phase ultimately results in a better product.

3.3.3.2 Treatment Post-Deployment

Another study that we are conducting entails the development and testing of VRGET for those returning from Iraq. This VR PTSD treatment program is currently in use at Naval Health Medical Center in San Diego. A second test site, at Marine Corps Base Camp Pendleton, is being implemented in March of 2006. By placing a patient in a virtual Iraqi war setting (see Figure 2), and then having him or her slowly experience that situation in a controlled way, the patient should begin to habituate to his or her specific PTSD symptoms and come to reappraise the situation, allowing emotional processing to fully occur.

Though the study, funded by ONR, is incomplete, initial pilot testing indicates that VRGET produces both subjective (self-report) and objective (physiological) arousal in individuals suffering from PTSD. Furthermore, preliminary data also indicate desensitization over time, with patients experiencing a lessening of symptoms and elimination of nightmares.

4.0 CONCLUSION

As aforementioned, the current rate of PTSD among combatants returning from duty in Iraq is about 19%, and a continuing upward trend seems especially likely given the unique nature of the Iraq theater. Clearly, PTSD is a serious health threat for military personnel. Learning to treat—or better still, *prevent*—this disorder is a task of paramount importance. The studies reviewed in this paper have shown positive results that imply a promising future for the application of VR therapy in the prevention and treatment of PTSD. While the results of VRMC’s studies are still preliminary, the initial data point to strong potential in using SIT as a powerful prevention tool and VRGET as an effective treatment option for PTSD.



Figure 2: Examples of VR Content Adaptable to PTSD Scenarios.

5.0 REFERENCES

- [1] NIH. A real illness: Post-traumatic stress disorder (PTSD).
- [2] Litz, B. T. (2004). National Center for PTSD, National Public Radio.
- [3] Hoge, C. W., Castro, C. A., Messer, S. C., McGurk, D., Cotting, D. I., & Koffman, R. L. (2004). Combat duty in Iraq and Afghanistan, mental health problems, and barriers to care. *The New England Journal of Medicine*, 351(1): 13-22.

- [4] Kessler, R. C., Sonnega, A., Bromet, E. J., Hughes, M. & Nelson, C. B. (1995). Post-traumatic stress disorder in the National Comorbidity Survey. *Archives of General Psychiatry*, 52, 1048-1060.
- [5] Boudewyns, P. (1990). Physiological response to combat memories and preliminary treatment outcome in Vietnam veteran PTSD patients treated with therapeutic exposure. *Behavior Therapy*, 21, 63-87.
- [6] Hamner, M.B., Robert, S., & Frueh, B.C. (2004). Treatment-resistant posttraumatic stress disorder: Strategies for intervention. *CNS Spectrums*, (9)10, 740-752.
- [7] Bradley, R., Greene, J., Russ, E., Dutra, L., & Westen, D. (2005). A multidimensional meta-analysis of psychotherapy for PTSD. *Am J Psychiatry*, 162(2), 214-227.
- [8] McNally, R., Bryant, R. A., & Ehlers, A. (2003). Does early psychological intervention promote recovery from posttraumatic stress? *PSPI* 4(2), 45-76.
- [9] Wessely, S., & Deahl, M. (2003). Psychological debriefing is a waste of time. *Br J Psychiatry* 183, 12-14.
- [10] McFarlane, A. C. (1986). Long term psychiatric morbidity after a natural disaster: Implications for disaster planners and emergency services. *Med J Aust*, 145, 561-563.
- [11] Foa, E. B., & Kozak, M. J. (1986). Emotional processing of fear: Exposure to corrective information. *Psychological Bulletin*, 99, 20-35.
- [12] Van Etten, M. L., & Taylor, S. (1998). Comparative efficacy of treatments for PTSD: A meta-analysis. *Clinical Psychology and Psychotherapy*, 5(3), 126-145.
- [13] Rothbaum, B. O., Hodges, L. F., Ready, D., Graap, K., & Alarcon, R. D. (2001). Virtual reality exposure therapy for Vietnam veterans with post-traumatic stress disorder. *J Clin Psychiatry*, 62(8), 617-622.
- [14] Jaycox, L. H., Foa, E. B., & Morral A. R. (1998). Influence of emotional engagement and habituation on exposure therapy for PTSD. *Journal of Consulting and Clinical Psychology*, 66, 185-192
- [15] Kosslyn, S. M., Brunn, J., Cave, K. R., & Walach, R. W. (1984). Individual differences in mental imagery ability: a computational analysis. *Cognition*, 18(1-3), 195-243.
- [16] Hoffman, H. G., Patterson, D. R., & Carrougner, G. J. (2000). Use of virtual reality for adjunctive treatment of adult burn pain during physical therapy: A controlled study. *The Clinical Journal of Pain*, 16(3), 244-250.
- [17] Wiederhold, B. K., & Wiederhold, M. D. (2001). Virtual reality technology in the treatment of anxiety disorders. In M. Akay & A. Marsh (Eds.), *Information Technologies in Medicine, Volume II* (Chapter 2). London: John Wiley & Sons.
- [18] Wiederhold, B. K., & Gevirtz, R. G. (1999). Enhancing treatment of specific phobias with virtual reality and physiological feedback. *Applied Psychophysiology and Biofeedback*, 24(2), 128-129.
- [19] Rothbaum, B. O., Hodges, L., Alarcon, R., Ready, D., Shahar, F., Graap, K., et. al (1999). Virtual reality exposure therapy for PTSD Vietnam veterans: A case study. *Journal of Traumatic Stress*, 12(2), 263-271.

Virtual Reality as a Tool in Early Interventions

- [20] Walshe, D. G., Lewis, E. J., Kim, S. I., O'Sullivan, K., & Wiederhold, B. K. (2003). Exploring the use of computer games and virtual reality in exposure therapy for fear of driving following a motor vehicle accident. *CyberPsychology & Behavior*, 6(3), 329-334.
- [21] Tarnanas, I., & Manos, G. C. (2001). Using virtual reality to teach special populations how to cope in crisis: The case of a virtual earthquake. In J.D. Westwood, H.M.
- [22] Wiederhold, B. K., Jang, D., Kim, S., & Wiederhold, M. D. (2001). Using advanced technologies to treat fear of driving. Presented at the 9th Annual Medicine Meets Virtual Reality Conference, Newport Beach, CA, January 24-27, 2001.
- [23] Difede, J., & Hoffman, H.G. (2002). Virtual reality exposure therapy for World Trade Center post-traumatic stress disorder: A case report. *CyberPsychology & Behavior*, 5(6), 529-535.
- [24] Basoglu, M., Livanou, M., & Salcioglu, E. (2003). A single session with an earthquake simulator for traumatic stress in earthquake survivors. *Am J Psychiatry*, 160, 788-790.
- [25] Rothbaum, B. O., Ruef, A. M., Litz, B. T., Han, H., & Hodges, L. (2003). Virtual reality exposure therapy of combat-related PTSD: A case study using psychophysiological indicators of outcome. *Journal of Cognitive Psychotherapy*, 17(2), 163-177.
- [26] Wald, J., & Taylor, S. (2003). Preliminary research on the efficacy of virtual reality exposure therapy to treat driving phobia. *CyberPsychology & Behavior*, 6(5), 459-465.
- [27] Wald, J. (2004). Efficacy of virtual reality exposure therapy for driving phobia: A multiple baseline across-subjects design. *Behavior Therapy*, 35(3), 621-635.
- [28] Wiederhold, B. K., & Wiederhold, M. D. (2005). Advances in the clinical delivery of virtual reality. Paper presented at the American Psychological Association Annual Convention, Washington, D.C., August 18-21, 2005.
- [29] Deahl, M., Srinivasan, M., Jones, N., Thomas, J., Neblett, C., & Jolly, A. (2000). Preventing psychological trauma in soldiers: the role of operational stress training and psychological debriefing. *Br J Med Psychol* 73, 77-85.
- [30] Wiederhold, M. D. (2003). Multi-Phased Student State Assessment Solution. Final Report. Contract No. DAAH01-03-C-R027. June 23. Arlington, VA: Defense Advanced Research Projects Agency.
- [31] Difede, J., Hoffman, H., Cukor, J., Patt, I., & Giosan, C. (2005). Virtual reality therapy for posttraumatic stress disorder following September 11, 2001. Paper presented at the 10th Annual Cybertherapy Conference, Basel, Switzerland, June 13-17, 2005.